Table of Contents

Chapter 1

1.0 Introduction 1
1.1 Executive Summary 2
Recommendations 9
1.2 Conclusions 29

Chapter 2

2.0 Virginia Energy Resources and Consumption 30
2.1 Energy Production 30
2.2 Energy Imports and Exports 37
2.3 Energy Consumption 43
2.4 Energy Production and Consumption Forecasts 47
2.5 Impact of Utility Regulation and Restructuring 49
2.6 Role of New Technologies 49
2.7 Opportunities and Challenges 56

Chapter 3

3.0 Energy Efficiency and Conservation 58
3.1 Improving Energy Efficiency and Conservation in Virginia 58
3.2 History of Energy Efficiency Savings and Spending - Electric Utilities 60
3.3 Opportunities and Challenges with Energy Efficiency and Conservation 60
3.4 The Case for Energy Efficiency and Conservation 61
3.5 Energy Efficiency and Conservation Potential in Virginia 63
3.6 Emerging Energy Efficiency Technologies and Practices 76

Chapter 4

4.0 Energy Infrastructure 78
4.1 Electrical System Infrastructure 80
4.2 Natural Gas Infrastructure 88
4.3 Petroleum Infrastructure 91
4.4 Coal Mining Infrastructure 93
4.5 Propane Infrastructure 95
4.6 Biomass/Waste Infrastructure 95
4.7 Renewable Energy Infrastructure - Wind Power 97
4.8 Alternative Fuels Production 98
4.9 Uranium/Nuclear Energy 100

Chapter 5

5.0 Energy and the Environment 102
5.1 Impacts of Energy Use on Air Quality 102
5.2 Impacts of Energy Use on Water Quality and Water Supplies 104
5.3 Land Use and Energy Consumption 105
5.4 Impacts of Energy Use on Climate Change 107
5.5 Environmental Case for Energy Efficiency and Renewable Energy 109
5.6 Incentives for Renewable Energy 110
5.7 Carbon Capture and Storage 111
5.8 Environmental Programs Affecting Energy Use 112

Chapter 6

6.0 Energy Research and Development 116
6.1 Energy R&D at Virginia Colleges and Universities 117
6.2 Energy R&D at Federal Laboratories in Virginia 130
6.3 Energy R&D at Virginia Industry 131
6.4 State Best Practices for Facilitating Energy R&D 135
6.5 Opportunities for Improving Virginia Coordination of Energy R&D 137

Chapter 7

7.0 Recommendations 142
7.1 Energy Efficiency and Conservation 144
7.2 Virginia's Energy Infrastructure and Supplies 160
7.3 Energy, the Environment, and Climate Change 166
7.4 Energy Research and Development 167
7.5 Energy Economic Development 168
7.6 Implementing Recommendations 170

Appendix A 172
Appendix B 174